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(54) PRINTED MATTER AUTHENTICATING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To prevent identification information embedded in a printed matter from being illegally read and the printed matter from being forged or altered by making mutually different a method for embedding the identification information into the printed matter and a method for extracting the identification information from the printed matter.

SOLUTION: This printed matter authenticating device is composed of an identification information embedding device for embedding the identification information into the printed matter and an identification information recognizing device for extracting the identification information from the printed matter and collating the information. The identification information embedding device is provided with an image input part, a preprocessing part, an array replacing part, and an image output part, and the identification information recognizing device is provided with an identification information extracting device for extracting the identification information and an identification information collating device for collating the extracted identification information with previously stored reference identification information data.

CLAIMS

[Claim(s)]

[Claim 1] It is a printed matter authentication device which comprises an

identification information recognition device which extracts and compares said identification information to printed matter from an identification information embedding device which embeds identification information and said printed matter. Said identification information embedding device is provided with an image input part, a pretreatment part, an arrangement substitution part, and an image output part, and said image input part changes inputted image data respectively corresponding to n original image data (however $n \geq 1$; n is taken as an integer.) into digital image data respectively, and n digital image data is inputted. After said pretreatment part's carrying out binarization of said n digital image data respectively and creating n binary pictures, expand said n binary pictures in all directions for predetermined magnification respectively, create n expansion pictures, and said arrangement substitution part, by creating two kinds of arrangement substitution pictures for every expansion picture of said n expansion pictures, embed 1 bit of identification information in each kind of two kinds of said arrangement substitution pictures of arrangement substitution picture, and said image output part, by outputting image data of an arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures for every expansion picture of said n expansion pictures, and printing n arrangement substitution pictures. In total, produce printed matter which embedded identification information of n bit, and said identification information recognition device comprises an identification information collating unit which compares identification information of an identification information extracting apparatus which extracts identification information of said n bit, and said extracted n bit with standard identification information data of n bit memorized beforehand. Said identification information extracting apparatus is provided with an image read section, the Fast Fourier Transform part, a Fourier-spectrum extraction part, and a Fourier-spectrum outputting part, and said image read section changes into digital image data image data of said n arrangement substitution pictures read in said printed matter respectively, and n digital image data is generated. Said Fast Fourier Transform part, said Fourier-spectrum extraction part, and said Fourier-spectrum outputting part, said n digital image data generated by said image read section is processed respectively. Extract identification information of said n bit from said printed matter using a Fourier spectrum of each kind of two kinds of said arrangement substitution pictures of arrangement substitution picture having a mutually different deviation for every expansion picture of said n expansion pictures, and said identification information collating unit, standard identification information data of identification information of said n bit extracted with said identification information extracting apparatus and said n bit is compared. A printed matter authentication device identifying said printed matter as genuine printed matter when a predetermined relation between identification information of said n bit and standard identification information data of said n bit is.

[Claim 2] Said image input part is provided with image input apparatus containing an image scanner or a video camera. The printed matter authentication device according to claim 1, creating n inputted image data by incorporating said n original

image data using said image input apparatus respectively changing said n inputted image data into digital image data respectively and considering it as said n digital image data.

[Claim 3] Said pretreatment part carries out binarization of said n digital image data inputted from said image input part respectively and creates said n binary pictures. The printed matter authentication device according to claim 1 or 2 expanding said n binary pictures in all directions at two times respectively and creating said n expansion pictures.

[Claim 4] Said arrangement substitution part divides into arrangement of 2x2 pixel units said n expansion pictures which are monochrome binary pictures which comprise a white picture element of a value of 1 and a black pixel of a value of 0 for every expansion picture. In arrangement of said all 2x2 pixel units for every expansion picture of said n expansion pictures, two kinds of arrangement substitution pictures, the first arrangement substitution picture and the second arrangement substitution picture, are created by changing the number of said white picture element and arrangement in accordance with a predetermined arrangement substitution rule. Character in which arrangement of said white picture element differs for every expansion picture of said n expansion pictures between said first arrangement substitution picture and said second arrangement substitution picture is used. The printed matter authentication device according to claim 3 embedding 1 bit of identification information in said first arrangement substitution picture and said second arrangement substitution picture.

[Claim 5] Said image output part is provided with image output equipment containing a printer or a printing machine. By outputting image data of an arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures to the surface of a predetermined substrate for every expansion picture of said n expansion pictures using said image output equipment, the printed matter authentication device according to any one of claims 1 to 4 printing n arrangement substitution pictures on the surface of said substrate.

[Claim 6] Said image read section is provided with image reading apparatus containing an image scanner or a video camera. By reading an arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures outputted to the surface of said substrate from said image output part for every expansion picture of said n expansion pictures using said image reading apparatus and changing into digital image data, the printed matter authentication device according to any one of claims 1 to 5 generating n digital image data from said printed matter.

[Claim 7] The printed matter authentication device according to any one of claims 1 to 6 wherein said Fast Fourier Transform part carries out Fast Fourier Transform of the n digital image data generated by said image read section respectively and obtains n digital data.

[Claim 8] The printed matter authentication device according to any one of claims 1 to 7 wherein said Fourier-spectrum extraction part extracts data of a Fourier

spectrum from said n digital data obtained in said Fast Fourier Transform part respectively and obtains data of n Fourier spectra.

[Claim 9] The printed matter authentication device according to any one of claims 1 to 8 outputting said Fourier-spectrum outputting part to said identification information collating unit by using as binary data data of said n Fourier spectra obtained by said Fourier-spectrum extraction part respectively.

[Claim 10] When the 2x2-pixel arrangement C_i ($i=1,2,3,4$) is expressed as $C_i = \{P_{11}P_{21}P_{12}P_{22}\}$ using the pixel value P_{xy} ($x=1,2; y=1,2$) for every expansion picture of said n expansion picture, said predetermined arrangement substitution rule $C_1 = \{0000\}$, when defining it as $C_2 = \{1111\}$, $C_3 = \{1000\}$, $C_4 = \{1011\}$ and $C_5 = \{1101\}$ and creating said first arrangement substitution picture, The printed matter authentication device according to any one of claims 4 to 9 characterized by transposing said C_2 to said C_5 after transposing said C_1 to said C_3 when transposing said C_2 to said C_4 and creating said second arrangement substitution picture after transposing said C_1 to said C_3 .

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the printed matter authentication device which extracts and compares the predetermined identification information which embedded predetermined identification information at printed matter and was embedded at printed matter and attests printed matter.

It is the art which can be used for discernment of the printed matter containing a security, a bill, a stamp, an inspection sticker, a stamp, a passport, an identification card, a pass permit, a membership card and a credit card or truth distinction.

[0002]

[Description of the Prior Art] as for the embedding of identification information and extraction of identification information, although each modulation method of amplitude, frequency and a phase is proposed as identification information embedding art to a picture, it is common to adopt the same method. Among these, although there are the method (Japanese Patent Application No. No. 213540 [08 to]) of carrying out direct modulation by modulo arithmetic etc. as an example of embedding of the identification information using amplitude modulation, if it is going to apply this to printed matter, it will be limited to printing methods such as a sublimated type, hot printing method in which intermediate color expression is possible and photogravure. Since [which is depended on the density unevenness of ink or time progress] it fades and is easy to be influenced by illumination unevenness etc., it is difficult to be stabilized and to extract the embedded identification information.

[0003] The thing (Nakamura Matsui: "synthetic encoding method of shade image and

text data using discrete orthogonal transformation" (IEICE TRANSACTIONS Vol. J72-D-II No. 3 and pp. 363-368-1989) using orthogonal transformation as an example of embedding of the identification information by frequency modulation etc. are proposed. An embedded domain is limited by the pattern in order that this method may generally embed identification information into the complicated portion of a shade. When the embedded domain at the time of applying to printed matter is narrow and the portion has dirt and a blur, extraction of identification information may become difficult.

[0004] There are what is depended on a concentration-patterns method (Japanese Patent Application No. No. 058617 [08 to]) a thing (Japanese Patent Application No. No. 047310 [62 to]) to depend on a dither method etc. in the example of embedding of the identification information using a phase modulation. Since these are methods which modulate the position of the pixel of the binary picture which changed concentration into density, they are applicable to a broad printing method. When concentration gradation is changed appropriately, since it becomes possible to embed identification information in the wide range of a picture, it is strong also to the dirt of printed matter or a blur. However, when extracting identification information, highly precise alignment is needed. When extracting identification information, it is necessary to carry out binarization of the multi-valued image inputted from an image scanner, a video camera etc., but if there are a fall in illumination, unevenness etc. of the sharpness of a multi-valued image, a pixel value may be unable to be restored correctly.

[0005]

[Problem(s) to be Solved by the Invention] In the device which performs attestation of printed matter and truth distinction by extracting and comparing the predetermined identification information which this invention embedded predetermined identification information at printed matter and was embedded at printed matter. When aiming at solving the above conventional problems and embedding identification information at printed matter. When performing embedding of the identification information by the phase encoding using the character in which arrangement of the white picture element in predetermined pixel arrangement differs mutually among two kinds of arrangement substitution pictures and extracting identification information from printed matter. The method of extracting identification information using the character in which the deviations of a Fourier spectrum differ mutually among two kinds of arrangement substitution pictures and embedding identification information to printed matter and the method of extracting identification information from printed matter by considering it as a mutually different method. Let it be a technical problem to prevent the forgery of unjust reading of identification information and printed matter and alteration which were embedded at printed matter.

[0006] An object of this invention is to compare the identification information extracted from printed matter with the standard identification information data set up beforehand and to realize attestation of printed matter. Under the present circumstances, although the printed matter in which identification information was

embedded provides 1-bit information by one image data in this invention. Let it be a technical problem to realize the printed matter authentication device which compares many information with standard identification information data and enables positive discernment of printed matter and truth distinction by embedding two or more bits identification information at printed matter using two or more image data.

[0007]

[Means for Solving the Problem] A printed matter authentication device of this invention is a printed matter authentication device which comprises an identification information recognition device which extracts and compares said identification information to printed matter from an identification information embedding device which embeds identification information and said printed matter. Said identification information embedding device is provided with an image input part, a pretreatment part, an arrangement substitution part, and an image output part. Said image input part changes inputted image data respectively corresponding to n original image data (however $n \geq 1$; n is taken as an integer.) into digital image data respectively, and n digital image data is inputted. After said pretreatment part's carrying out binarization of said n digital image data respectively and creating n binary pictures, expand said n binary pictures in all directions for predetermined magnification respectively, create n expansion pictures, and said arrangement substitution part, by creating two kinds of arrangement substitution pictures for every expansion picture of said n expansion pictures, embed 1 bit of identification information in each kind of two kinds of said arrangement substitution pictures of arrangement substitution picture, and said image output part, by outputting image data of an arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures for every expansion picture of said n expansion pictures, and printing n arrangement substitution pictures. In total, produce printed matter which embedded identification information of n bit, and said identification information recognition device. It comprises an identification information collating unit which compares identification information of an identification information extracting apparatus which extracts identification information of said n bit, and said extracted n bit with standard identification information data of n bit memorized beforehand. Said identification information extracting apparatus is provided with an image read section, the Fast Fourier Transform part, a Fourier-spectrum extraction part, and a Fourier-spectrum outputting part. Said image read section changes into digital image data image data of said n arrangement substitution pictures read in said printed matter respectively, and n digital image data is generated. Said Fast Fourier Transform part, said Fourier-spectrum extraction part, and said Fourier-spectrum outputting part, said n digital image data generated by said image read section is processed respectively. Extract identification information of said n bit from said printed matter using a Fourier spectrum of each kind of two kinds of said arrangement substitution pictures of arrangement substitution picture having a mutually different deviation for every expansion picture of said n expansion

pictures and said identification information collating unit. When standard identification information data of identification information of said n bit extracted with said identification information extracting apparatus and said n bit is compared and a predetermined relation between identification information of said n bit and standard identification information data of said n bit is it is characterized by identifying said printed matter as genuine printed matter.

[0008] A printed matter authentication device of this invention is provided with image input apparatus in which said image input part contains an image scanner or a video camera. It is characterized by creating n inputted image data by incorporating said n original image data using said image input apparatus respectively, changing said n inputted image data into digital image data respectively, and considering it as said n digital image data.

[0009] Said pretreatment part carries out binarization of said n digital image data inputted from said image input part respectively, and a printed matter authentication device of this invention creates said n binary pictures. It is characterized by expanding said n binary pictures in all directions at two times respectively, and creating said n expansion pictures.

[0010] A printed matter authentication device of this invention divides into arrangement of 2x2 pixel units said n expansion pictures in which said arrangement substitution parts are the monochrome binary pictures which comprise a white picture element of a value of 1 and a black pixel of a value of 0 for every expansion picture. In arrangement of said all 2x2 pixel units for every expansion picture of said n expansion pictures, two kinds of arrangement substitution pictures, the first arrangement substitution picture and the second arrangement substitution picture, are created by changing the number of said white picture element and arrangement in accordance with a predetermined arrangement substitution rule. It is characterized by embedding 1 bit of identification information for every expansion picture of said n expansion pictures using character in which arrangement of said white picture element differs in said first arrangement substitution picture and said second arrangement substitution picture between said first arrangement substitution picture and said second arrangement substitution picture.

[0011] A printed matter authentication device of this invention is provided with image output equipment in which said image output part contains a printer or a printing machine. By outputting image data of an arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures to the surface of a predetermined substrate for every expansion picture of said n expansion pictures using said image output equipment, it is characterized by printing n arrangement substitution pictures on the surface of said substrate.

[0012] A printed matter authentication device of this invention is provided with image reading apparatus by which said image read section contains an image scanner or a video camera. By reading an arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures outputted to the surface of said substrate from said image output part for every expansion picture of said n expansion pictures using said image reading apparatus and changing into

digital image dataIt is characterized by generating n digital image data from said printed matter.

[0013]A printed matter authentication device of this invention is characterized by said Fast Fourier Transform part's carrying out Fast Fourier Transform of the n digital image data generated by said image read sectionrespectivelyand obtaining n digital data.

[0014]A printed matter authentication device of this invention is characterized by said Fourier-spectrum extraction part's extracting data of a Fourier spectrum from said n digital data obtained in said Fast Fourier Transform partrespectivelyand obtaining data of n Fourier spectra.

[0015]A printed matter authentication device of this invention is characterized by said Fourier-spectrum outputting part outputting to said identification information collating unit by using as binary data data of said n Fourier spectra obtained by said Fourier-spectrum extraction partrespectively.

[0016]A printed matter authentication device of this invention said predetermined arrangement substitution ruleWhen the 2x2-pixel arrangement C_i ($i=1,2,3,4$) is expressed as $C_i = \begin{Bmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{Bmatrix}$ using the pixel value P_{xy} ($x=1,2; y=1,2$) for every expansion picture of said n expansion pictures $C_1 = \begin{Bmatrix} 0 & 0 \\ 0 & 0 \end{Bmatrix}$ $C_2 = \begin{Bmatrix} 1 & 1 \\ 1 & 1 \end{Bmatrix}$ $C_3 = \begin{Bmatrix} 1 & 0 \\ 0 & 0 \end{Bmatrix}$ $C_4 = \begin{Bmatrix} 0 & 1 \\ 1 & 1 \end{Bmatrix}$ and creating said first arrangement substitution pictureWhen transposing said C_2 to said C_4 and creating said second arrangement substitution pictureafter transposing said C_1 to said C_3 after transposing said C_1 to said C_3 it is characterized by transposing said C_2 to said C_5 .

[0017]

[Embodiment of the Invention]Although the embodiment of the printed matter authentication device concerning this invention is hereafter described with reference to drawings based on an exampleThe mode of operation of the printed matter authentication device concerning this invention is not limited to the example shown belowand if it is within the limits of the technical matter indicated to the claim concerning this inventionit can adopt various kinds of modes. Although especially the case where create two kinds of arrangement substitution pictures from the expansion picture acquired in the following examples by expanding the binary picture corresponding to original image data to two times in all directionsrespectivelyand 1 bit of identification information is embedded in each kind of two kinds of arrangement substitution pictures of arrangement substitution picture is explainedIn accordance with a predetermined arrangement substitution ruletwo kinds of arrangement substitution pictures are created from the expansion picture acquired by expanding the binary picture corresponding to original image data for predetermined magnification for every directionIt is also possible by embedding 1 bit of identification information in each kind of two kinds of arrangement substitution pictures of arrangement substitution picture to constitute the printed matter authentication device of this invention.

[0018](Printed matter authentication device whole) Drawing 1 is a figure for explaining the entire configuration of the example of the printed matter

authentication device concerning this invention. Image data which embedded identification information as the printed matter authentication device concerning this invention was shown in drawing 1 (in this example.) They are "arrangement substitution picture" I mentioned later – NI. Identification information is extracted from the identification information embedding device which produces the printed matter in which it outputted and identification information was embedded and printed matter. It comprises an identification information recognition device to compare (carry out discernment of printed matter and truth distinction as compared with the standard identification information data beforehand set up in the contents of identification information.). And the identification information recognition device comprises an identification information collating unit which compares the identification information extracting apparatus which extracts and outputs identification information and the extracted identification information with the standard identification information data set up beforehand.

[0019] Here when the identification information embedding device which constitutes the printed matter authentication device concerning this invention produces the printed matter which embedded identification information it is needed. And when the identification information recognition device which constitutes the printed matter authentication device concerning this invention attests the printed matter in which identification information was embedded it is needed.

[0020] The identification information embedded in the printed matter authentication device concerning this invention at printed matter is n pieces (however $n \geq 1$; n is taken as an integer.). Hereafter n is defined in a similar manner. It is constituted by image data and 1 bit of identification information can be embedded at printed matter using one image data. Therefore it becomes possible to extract the identification information of n bit from the printed matter in which n image data is printed.

[0021] In the example shown by drawing 1 in an identification information embedding device four image data of arrangement substitution picture I later mentioned as identification information – NI is outputted on a predetermined substrate respectively and printed matter is produced. And in an identification information extracting apparatus after extracting identification information from four image data read in printed matter respectively binarization of the extracted identification information is carried out and 4-bit identification information is outputted. Next the outputted 4-bit identification information is compared with the standard identification information data beforehand memorized in the identification information collating unit and discernment and recognition of the identification information extracted by carrying out truth distinction are performed in the contents.

[0022] The feature of the printed matter authentication device concerning this invention is the following point.

(1) In the printed matter authentication device concerning this invention the method of embedding identification information at printed matter differs from the method of extracting the identification information embedded at printed matter.

Therefore when identification information is embedded at printed matter the identification information embedded at printed matter cannot be grasped only by reading an image data printed by this printed matter. That is according to the printed matter authentication device concerning this invention the printed matter in which the identification information kept secret was embedded is producible. The method of embedding identification information with an identification information embedding device and how an identification information extracting apparatus extracts identification information are explained in detail later.

[0023] (2) In the printed matter authentication device concerning this invention one image data printed by printed matter provides 1 bit of identification information. Therefore when printing an image data and embedding the identification information of n bit at printed matter it becomes possible to embed 2^n a kind of identification information at printed matter. That is when the identification information of n bit is embedded at printed matter one image data printed by printed matter provides the 1-bit information which constitutes the identification information of n bit embedded at printed matter.

[0024] For example when using the printed matter authentication device concerning this invention as an authentication device of a membership card the identification information of n bit can give a member's password. It may constitute from a membership card with a photograph so that 1 bit of identification information of the identification information of n bit may make it correspond with the personal characteristics (existence of glasses wear etc.) of the member who can grasp with a photograph and may be given.

[0025] (Identification information embedding device) The concrete composition of the printed matter authentication device concerning this invention is explained hereafter. First the identification information embedding device which embeds identification information at printed matter is explained.

[0026] Drawing 2 is a block diagram showing the example of the identification information embedding device of a printed matter authentication device and an identification information extracting apparatus concerning this invention. The identification information embedding device 1 shown in drawing 2 possesses the image input part 3 the pretreatment part 4 the arrangement substitution part 5 and the image output part 6 and the identification information extracting apparatus 2 possesses the image read section 7 the Fast Fourier Transform part 8 the Fourier-spectrum extraction part 9 and the Fourier-spectrum outputting part 10.

[0027] The image input part 3 is provided with an image scanner a video camera etc. inputs the original image 11 and changes it into digital image data. The pretreatment part 4 carries out binarization of the digital image data of the original image 11 creates a binary picture after that expands a binary picture to two times in all directions respectively and creates an expansion picture. In all the arrangement which divided the expansion picture into 2×2 pixel units the arrangement substitution part 5 creates two kinds of arrangement substitution pictures by changing the number of the white picture element of the value of 1 and arrangement in accordance with an arrangement substitution rule. These details

are explained in detail later.

[0028]By providing the image output part 6 with image output equipmentsuch as a printer and a printing machineand outputting n arrangement substitution pictures on the predetermined substrate which contains papera plasticmetaland clothrespectivelyThe printed matter containing a securitya billa stampa inspection stickera stampa passportan identification carda pass permita membership cardand a credit card is produced.

[0029](Identification information recognition device) An identification information recognition device comprises an identification information collating unit which compares the identification information extracting apparatus which extracts identification informationand the extracted identification information with the standard identification information data beforehand memorized by memory storage. The identification information extracting apparatus is provided with the image read sectionthe Fast Fourier Transform partthe Fourier-spectrum extraction partand the Fourier-spectrum outputting part.

[0030]In the identification information extracting apparatus 2 shown in drawing 2the image read section 7 is provided with an image scannera video cameraetc.reads an arrangement substitution picture in the printed matter 12 in which identification information was embeddedand changes it into digital image data. The Fast Fourier Transform part 8 carries out Fast Fourier Transform of the arrangement substitution picture changed into digital image data. The Fourier-spectrum extraction part 9 extracts a Fourier spectrum from the digital data (a real partimaginary parta phasea Fourier spectrum) obtained by carrying out Fast Fourier Transform of the arrangement substitution picture.

[0031]The Fourier-spectrum outputting part 10 by comparing the data of the standard Fourier spectrum set as each arrangement substitution picture at the storage parts store of the Fourier-spectrum outputting part 10 beforehand corresponding to the data of the Fourier spectrum extracted by the Fourier-spectrum extraction part 9 by a comparison meansThe result of "1"the binarization data of "0"or either of "non-Shinsei" is outputted.

[0032]the data of the Fourier spectrum extracted by the Fourier-spectrum extraction part 9 being displayed on displayssuch as CRT and a liquid crystal displayor in the identification information extracting apparatus 2After providing the information which can output and view the data of the Fourier spectrum extracted by the Fourier-spectrum extraction part 9 using output unitssuch as a printer and a printing machineattestation of the printed matter by viewing can also be enabled.

[0033]The identification information collating unit possesses a collation means and memory storageand compares with memory storage the binarization data of n bit outputted from the Fourier-spectrum outputting part 10 by the standard identification information data and the collation means which are memorized beforehand. By this collationit is judged whether predetermined identification information is given to printed matterand attestation of printed matter is performed.

[0034](Operation of an identification information embedding device) The flow chart

shown in drawing 4 explains an operation of the example of the identification information embedding device in the printed matter authentication device concerning this invention and an identification information extracting apparatus. Drawing 4 (a) is a flow chart of the processing in the identification information embedding device 1 of drawing 2 and drawing 4 (b) is a flow chart of the processing in the identification information extracting apparatus 2 of drawing 2.

[0035] First an identification information embedding routine is explained in drawing 4 (a). In step 100 an original image is read and it changes into digital image data. In Step 101 binarization of the digital image data of the incorporated original image is carried out and a binary picture is created. In Step 102 a binary picture is expanded to two times in all directions respectively and the expansion picture $F_{gt}(xy)$ is created.

[0036] In Step 103 two kinds of arrangement substitution pictures are created in each arrangement which divided $F_{gt}(xy)$ into 2×2 pixel units by changing the number of the white picture element of the value of 1 and arrangement in accordance with a predetermined arrangement substitution rule.

[0037] Drawing 3 is a figure showing the 2×2 -pixel arrangement defined under the predetermined arrangement substitution rule concerning this invention. $F_{st}(xy)$ ($t = 1, 2, \dots$) and the second arrangement substitution picture are made [an expansion picture] into $F'_{st}(xy)$ ($t = 1, 2, \dots$) for $F_{gt}(xy)$ ($t = 1, 2, \dots$) and the first arrangement substitution picture. Each arrangement which divided $F_{gt}(xy)$ into 2×2 pixel units is certainly either C1 or C2.

[0038] After an arrangement permutation means transposes C1 to C3 in each arrangement which divided $F_{gt}(xy)$ into 2×2 pixel units C2 is transposed to C4 $F_{st}(xy)$ is created after transposing C1 to C3 in each arrangement which divided $F_{gt}(xy)$ into 2×2 pixel units C2 is transposed to C5 and $F'_{st}(xy)$ is created. Since arrangement of the white picture element of the value of 1 differs mutually it is possible to embed 1 bit of identification information at $F_{st}(xy)$ and $F'_{st}(xy)$ at C5 in C4 and $F'_{st}(xy)$ in $F_{st}(xy)$.

[0039] In Step 104 by outputting the image data of either $F_{st}(xy)$ or $F'_{st}(xy)$ using devices such as a printer and a printing machine the printed matter in which identification information was embedded is produced and an identification information embedding routine is ended.

[0040] Drawing 5 is a figure showing an example of the printed matter in which the identification information concerning this invention was embedded. In viewing the difference between $F_{s1}(xy)$ of drawing 5 (a) and $F'_{s1}(xy)$ of drawing 5 (b) cannot be recognized easily.

[0041] By the way in the printed matter authentication device concerning this invention one image data printed by printed matter provides 1 bit of identification information. After printing one image data on the predetermined substrate and embedding 1 bit of identification information at printed matter 1 bit of identification information can also be extracted and compared from printed matter and after printing two or more image data on the predetermined substrate and embedding two or more bits identification information at printed matter two or more bits

identification information can also be extracted and compared from printed matter. Anyway in the printed matter authentication device concerning this invention 2^n a kind (n bit) of identification information can be embedded at the printed matter produced by outputting n image data on a predetermined substrate.

[0042] Thus after embedding identification information at printed matter in order to make it possible to extract and compare identification information from printed matter the following composition is adopted by this invention. Namely the embedding device of identification information is provided with the image input part the pretreatment part the arrangement substitution part and the image output part and said image input part changes the inputted image data respectively corresponding to n original image data into digital image data respectively input n digital image data and said pretreatment part after carrying out binarization of said n digital image data respectively and creating n binary pictures expands said n binary pictures in all directions for predetermined magnification respectively create n expansion pictures and said arrangement substitution part by creating two kinds of arrangement substitution pictures for every expansion picture of said n expansion pictures embeds 1 bit of identification information in each kind of two kinds of said arrangement substitution pictures of arrangement substitution picture and said image output part by outputting the image data of the arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures for every expansion picture of said n expansion pictures and printing n arrangement substitution pictures the printed matter which embedded the identification information of n bit in total is produced. Here all of each original image data of n original image data can also be constituted so that it may become the same original image data but it is not necessary to constitute all of each original image data of n original image data so that it may become the same original image data. Drawing 1 shows the case where print four arrangement substitution picture $I - N$ as $n = 4$ and 4-bit identification information is embedded.

[0043] An identification information extraction routine is explained using (an operation of an identification information recognition device) next drawing 4 (b). In Step 200 an arrangement substitution picture is read in the printed matter in which identification information was embedded and it changes into digital image data. In Step 201 Fast Fourier Transform of the arrangement substitution picture changed into digital image data is carried out.

[0044] In Step 202 a Fourier spectrum is extracted from the digital data obtained by carrying out Fast Fourier Transform of the arrangement substitution picture. By comparing the data of the standard Fourier spectrum set as each arrangement substitution picture in Step 203 at the storage parts store of the Fourier-spectrum outputting part beforehand corresponding to the data of the extracted Fourier spectrum by a comparison means the result of "1" the binarization data of "0" or either of "non-Shinsei" is outputted and an identification information extraction routine is ended. the data of the Fourier spectrum extracted by the Fourier-spectrum extraction part being displayed on display such as CRT and a liquid crystal display in an identification information extraction routine After

providing the information which can output and view the data of the Fourier spectrum extracted by the Fourier-spectrum extraction part using output units such as a printer and a printing machine. Attestation of the printed matter by viewing can also be enabled.

[0045] Drawing 6 is a figure showing an example which outputted the Fourier spectrum about the image data of each printed matter of drawing 5 concerning this invention using the printer. $|fs1(uv)|$ of drawing 6 (a) is a Fourier spectrum of $F_s1(xy)$ of drawing 5 (a) and the pattern of a circle configuration or semicircle shape is perpendicularly located in a line. On the other hand although $|f's1(uv)|$ of drawing 6 (b) is a Fourier spectrum of $F's1(xy)$ of drawing 5 (b) the pattern of a circle configuration or semicircle shape is horizontally located in a line.

[0046] By thus $|fs1(uv)|$ and $|f's1(uv)|$. Since the deviations (bias of a direction) of a Fourier spectrum differ in a comparison means to mention later pattern recognition is easily possible and viewing can also recognize easily the difference between $|fs1(uv)|$ and $|f's1(uv)|$. Therefore it is possible to extract 1 bit of identification information embedded $F_s1(xy)$ and $F's1(xy)$.

[0047] Drawing 7 is a figure showing expansion picture $Fg2(xy)$ which has a circular pattern its first arrangement substitution picture $Fs2(xy)$ and the second arrangement substitution picture $F's2(xy)$. In viewing the difference between $Fs2(xy)$ and $F's2(xy)$ cannot be recognized.

[0048] Drawing 8 is a figure showing Fourier-spectrum $|fs2(uv)|$ of $Fs2(xy)$ of drawing 7 (b) and Fourier-spectrum $|f's2(uv)|$ of $F's2(xy)$ of drawing 7 (c). Since the deviations of a Fourier spectrum differ about $|fs2(uv)|$ and $|f's2(uv)|$ in a comparison means to mention the difference later comparison of a pattern is easily possible and viewing can also be recognized easily. Therefore it is possible to extract identification information from arrangement substitution picture $Fs2(xy)$ where identification information was embedded and $F's2(xy)$.

[0049] Drawing 9 is a figure showing $Fs2(xy)$ of drawing 7 (b) and the two pictures $Fa2(xy)$ and $Fb2(xy)$ which constitute it. $Fa2(xy)$ is the picture which packed C3 and it is a picture of $Fs2(xy)$ and the same size. $Fb2(xy)$ is the difference image which deducted $Fs2(xy)$ to $Fa2(xy)$ and the relation between each picture is given by several 1.

[0050]

[Equation 1] $Fs2(xy) = Fa2(xy) + Fb2(xy)$ [0051] Drawing 10 is a figure showing $F's2(xy)$ of drawing 7 (c) two picture $F'a2(xy)$ which constitute it and $F'b2(xy)$. The relation between each picture is given by several 2.

[0052]

[Equation 2] $F's2(xy) = F'a2(xy) + F'b2(xy)$ [0053] However several 3 is realized between $F'a2(xy)$ and $Fa2(xy)$.

[0054]

[Equation 3] $F'a2(xy) = Fa2(xy)$ [0055] Drawing 11 is a figure showing the Fourier spectrum of each picture of drawing 9. The center of each Fourier spectrum is a dc component because of an optical display. The domain of each Fourier spectrum is set to DR1. DR1 is a field which fills $-1/2 \leq u < 1/2$ and $2 \leq v < 1/2$. The line

and u of $v=1/2$ = since one half of sequences are not included in DR1 as for $|f_a2(uv)|$ in coordinates (uv) a Fourier spectrum appears in four points $(-1/2-1/2)(0-1/2)(-1/20)$ and (00) . These four points are set to domain DR2. The domain except DR1 to DR2 is set to DR3. In DR3 since it is $|f_a2(uv)|=0$ in DR3 $f_a2(uv)=0$ is realized. From the additivity rule of the Fourier transform several 4 is realized in DR3.

[0056]

[Equation 4] $f_s2(uv)=f_b2(uv)$ [0057] As a result several 5 is realized in DR3.

[0058]

[Equation 5] $|f_s2(uv)|=|f_b2(uv)|$ [0059] Drawing 12 is a figure showing the Fourier spectrum of each picture of drawing 10. Here the relation between $|f'_a2(uv)|$ and $|f_a2(uv)|$ is given by several 6.

[0060]

[Equation 6] $|f'_a2(uv)|=|f_a2(uv)|$ [0061] Several 7 is realized in DR3.

[0062]

[Equation 7] $|f'_s2(uv)|=|f_b2(uv)|$ [0063] Although the influence of $f_a2(uv)|$ appears in DR2 of $|f_s2(uv)|$ and the influence of $|f'_a2(uv)|$ appears in DR2 of $|f'_s2(uv)|$ the rate of DR2 occupied to DR1 is very small. Therefore in DR3 which occupies the great portion of DR1 from several 5 and several 7 being realized. | The main element which makes Fourier-spectrum distribution of $f_s2(uv)|$ produce a deviation is $|f_b2(uv)|$ and it turns out that the main element which makes Fourier-spectrum distribution of $|f'_s2(uv)|$ produce a deviation is $|f'_b2(uv)|$.

[0064] Since $F_s2(xy)$ comprises C3 and C4 in space image $F_b2(xy)$ of $|f_b2(uv)|$ 2-pixel or more (multiple of 2) continuation of the white picture element of the value of 1 of the line whose total pixel value is not 0 is carried out and it appears. On the other hand about each sequence of $F_b2(xy)$ the neighbors of the white picture element of the value of 1 certainly become a black pixel of the value of 0 in the sequence whose total pixel value is not 0. For this reason the deviation for $|f_b2(uv)|$ to have a small rate of the Fourier spectrum which exists in the high frequency region $(1/4 \leq u < 1/2)$ of u shaft orientations and for the rate of the Fourier spectrum which exists in the high frequency region $(1/4 \leq v < 1/2)$ of v shaft orientations to be large is shown.

[0065] Since $F'_s2(xy)$ comprises C3 and C5 in space image $F'_b2(xy)$ of $|f'_b2(uv)|$ a total pixel value carries out 2-pixel or more (multiple of 2) continuation of the white picture element of the value of 1 of the sequence which is not 0 and it appears. On the other hand about each line of $F'_b2(xy)$ the neighbors of the white picture element of the value of 1 certainly become a black pixel of the value of 0 in the line whose total pixel value is not 0.

[0066] For this reason deviation for $|f'_b2(uv)|$ to have a small rate of a Fourier spectrum which exists in a high frequency region $(1/4 \leq v < 1/2)$ of v shaft orientations and for a rate of a Fourier spectrum which exists in a high frequency region $(1/4 \leq u < 1/2)$ of u shaft orientations to be large is shown. | By $|f_b2(uv)|$ and $|f'_b2(uv)|$ since deviations of a Fourier spectrum differ it becomes possible to extract identification information from an arrangement substitution picture where identification information was embedded.

[0067]Although it has composition which extracts identification information of n bit embedded at printed matter as above-mentioned and is compared in this invention, this specifically becomes possible by composition of an identification information recognition device shown in drawing 13.

[0068]Namely, an identification information recognition device comprises an identification information collating unit which compares identification information of an identification information extracting apparatus which extracts identification information of n bit and said extracted n bit with standard identification information data of n bit memorized beforehand. An identification information extracting apparatus is provided with an image read section, the Fast Fourier Transform part, a Fourier-spectrum extraction part and a Fourier-spectrum outputting part, and an image read section. Change into digital image data, image data of n arrangement substitution pictures read in printed matter, respectively, and n digital image data is generated. The Fast Fourier Transform part, a Fourier-spectrum extraction part and a Fourier-spectrum outputting part, n digital image data generated by an image read section is processed, respectively. An identification information embedding device extracts identification information of n bit from printed matter using a Fourier spectrum of each kind of two kinds of arrangement substitution pictures created for every original image data of n original image data of arrangement substitution picture having a mutually different deviation. An identification information collating unit compares standard identification information data of identification information of n bit and n bit extracted with an identification information extracting apparatus. When a predetermined relation between identification information of n bit and standard identification information data of n bit in said printed matter is identified as genuine printed matter.

[0069]A Fourier-spectrum outputting part in an identification information extracting apparatus. By comparing data of a standard Fourier spectrum set as each arrangement substitution picture at a storage parts store of a Fourier-spectrum outputting part beforehand corresponding to data of an extracted Fourier spectrum by a comparison means. A result of "1" binarization data of "0" or either of "non-Shinsei" is outputted.

[0070]If this point is explained in full detail, a Fourier-spectrum outputting part possesses a storage parts store and a comparison means, and data of a standard Fourier spectrum is beforehand memorized by storage parts store. And data of a Fourier spectrum extracted by a Fourier-spectrum extraction part is compared in data and a comparison means of a standard Fourier spectrum. Data of $|fst(uv)|$ and $|fst(uv)|$ is specifically beforehand memorized by storage parts store. It is outputted when data of an extracted Fourier spectrum corresponds to $|fst(uv)|$. It is constituted so that a signal meaning an unauthorized use may be outputted when "0" is outputted when data of an extracted Fourier spectrum corresponds to $|fst(uv)|$ and data of an extracted Fourier spectrum corresponds to neither.

[0071]data of a Fourier spectrum extracted by a Fourier-spectrum extraction part being displayed on displays such as CRT and a liquid crystal display in an identification information recognition device. After providing information which can

output and view data of a Fourier spectrum extracted by a Fourier-spectrum extraction part using output unitssuch as a printer and a printing machineattestation of printed matter by viewing can also be enabled.

[0072]An identification information collating unit possesses a collation means and memory storageand compares with memory storage binarization data of n bit outputted from a Fourier-spectrum outputting part of an identification information extracting apparatus by standard identification information data and a collation means which are memorized beforehandWhen a predetermined relation between standard identification information data beforehand memorized by binarization data and memory storage of n bit outputted from a Fourier-spectrum outputting part of an identification information extracting apparatus isprinted matter is attested as genuine printed matter.

[0073]For examplewhen a printed matter authentication device of this invention is used as an authentication device of a pass permit0101is beforehand stored in memory storage of an identification information collating unit as standard identification information dataWhen binarization data outputted from a Fourier-spectrum outputting part of an identification information extracting apparatus as identification information embedded at a pass permit is in agreement with "0101" which is standard identification information datathere is also the method of use whose passing is enabled.

[0074]As mentioned abovealthough an embodiment of a printed matter authentication device concerning this invention has been described based on a concrete exampleA mode of operation of a printed matter authentication device concerning this invention is not limited to the above-mentioned exampleand if it is within the limits of a technical matter indicated to a claim concerning this inventionit can adopt various kinds of modes. Although especially a case where created two kinds of arrangement substitution pictures from an expansion picture acquired in the above-mentioned example by expanding a binary picture corresponding to original image data to two times in all directionsrespectivelyand 1 bit of identification information was embedded in each kind of two kinds of arrangement substitution pictures of arrangement substitution picture was explainedIn accordance with a predetermined arrangement substitution ruletwo kinds of arrangement substitution pictures are created from an expansion picture acquired by expanding a binary picture corresponding to original image data for predetermined magnification for every directionIt is also possible by embedding 1 bit of identification information in each kind of two kinds of arrangement substitution pictures of arrangement substitution picture to constitute a printed matter authentication device of this invention. In producing printed matter which printed n arrangement substitution pictures in an identification information embedding deviceand embedded identification information of n bitextracting said predetermined characteristic which said ink shows under said predetermined conditions in an identification information extracting apparatusafter printing an arrangement substitution picture of a piece at least using ink in which the predetermined characteristic is shown under predetermined conditions -- said --

image data of an arrangement substitution picture of a piece may be read at least.
[0075]

[Effect of the Invention]The printed matter authentication device concerning this invention is a binary picture by which the white picture element of the value of 1 and the black pixel of the value of 0 have been arranged in accordance with a predetermined arrangement substitution ruleSince identification information is extracted from the printed matter produced by outputting the binary picture where predetermined identification information was embedded on a predetermined substrateAfter [which is depended on the density unevenness of ink or time progress compared with the case where identification information is extracted from the shade image of printed matter] having fadedbeing hard to be influenced by illumination unevenness etc.being stabilized from printed matter and extracting identification informationit becomes possible to attest printed matter correctly. Since identification information is embedded in the printed matter authentication device concerning this invention at the whole binary picture which comprises a white picture element of the value of 1 and a black pixel of the value of 0 using a phase modulationThe embedded domain of identification information is not restricted by the pattern like [in the case of embedding identification information at printed matter using frequency modulation].

[0076]In the printed matter authentication device concerning this inventionsince identification information is extracted using the deviation which appears in the Fourier spectrum of the image data read in the printed matter in which identification information was embeddedwhen extracting identification information from printed matterhighly precise alignment is not needed. In the printed matter authentication device concerning this inventionsince it is not necessary to necessarily carry out binarization of the image data read in an image scanner a video camera etc. when extracting identification information from printed matterit is hard to receive the fall of the sharpness of image data and the influence of illumination unevenness which were read. For this reasonin the printed matter authentication device concerning this inventionit becomes possible to be stabilized conventionally and to attest printed matter correctly.

[0077]The printed matter authentication device concerning this invention by creating two kinds of arrangement substitution pictures for every original image data of n original image data1 bit of identification information is embedded in each kind of two kinds of arrangement substitution pictures of arrangement substitution pictureand since it becomes possible from printed matter to extract and compare the identification information of n bitit becomes possible to attest printed matter correctly using more identification information. And the printed matter in which the identification information produced using the printed matter authentication device concerning this invention was embeddedIt is a binary picture by which the white picture element of the value of 1 and the black pixel of the value of 0 have been arranged in accordance with a predetermined arrangement substitution ruleSince it is the printed matter which printed the binary picture where predetermined identification information was embedded simple to various mediasuch as paper a

plastic metal and cloth using various output units such as a printer and a printing machine. The printed matter authentication device of this invention can be used for the various field which requires discernment of the printed matter containing a security bill, a stamp, an inspection sticker, a stamp, a passport, an identification card, a pass permit, a membership card and a credit card and truth distinction.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The figure for explaining the entire configuration of the example of the printed matter authentication device concerning this invention.

[Drawing 2] The block diagram showing an example of an identification information embedding device and an identification information extracting apparatus.

[Drawing 3] The figure showing the 2x2-pixel arrangement defined under the arrangement substitution rule.

[Drawing 4] The flow chart explaining the embedding and the extraction method of identification information.

[Drawing 5] The figure showing an example of the printed matter in which identification information was embedded.

[Drawing 6] The figure showing an example which outputted the Fourier spectrum about the image data of each printed matter of drawing 5 using the printer.

[Drawing 7] The figure showing expansion picture $Fg_2(xy)$ which has a circular pattern, its first arrangement substitution picture $Fs_2(xy)$ and the second arrangement substitution picture $F's_2(xy)$.

[Drawing 8] The figure showing Fourier-spectrum $|fs_2(uv)|$ of $Fs_2(xy)$ of drawing 7 (b) and Fourier-spectrum $|f's_2(uv)|$ of $F's_2(xy)$ of drawing 7 (c).

[Drawing 9] The figure showing $Fs_2(xy)$ of drawing 7 (b) and the two pictures $Fa_2(xy)$ and $Fb_2(xy)$ which constitute it.

[Drawing 10] The figure showing $F's_2(xy)$ of drawing 7 (c) and two pictures $F'a_2(xy)$ and $F'b_2(xy)$ which constitute it (xy).

[Drawing 11] The figure showing the Fourier spectrum of each picture of drawing 9.

[Drawing 12] The figure showing the Fourier spectrum of each picture of drawing 10.

[Drawing 13] The figure explaining the identification information recognition device of this invention.

[Description of Notations]

- 1 Identification information embedding device
- 2 Identification information extracting apparatus
- 3 Image input part
- 4 Pretreatment part
- 5 Arrangement substitution part
- 6 Image output part
- 7 Image read section

- 8 Fast Fourier Transform part
 - 9 Fourier-spectrum extraction part
 - 10 Fourier-spectrum outputting part
 - 11 Original image
 - 12 Printed matter in which identification information was embedded
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